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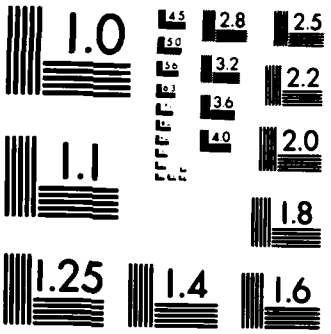

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This interm report covers work performed during the initial grant period, September 30, 1983 through October 1, 1984, on the topic of laser-fluorescence measurements of ion beam scattering and transport of background ions during beam-plasma interactions. Achievements to date include i. contruction and operation of the plasma device, ii. assembly of a diagnostic pulsed laser, and iii. assembly and emplacement of the detection system. Future work plans, personnel changes and general scientific activities are described. Original contains Full-Size Reproducible Inclusions.

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GRANT No. AFOSR-83-0325

Effective Date 30 September 1983

Duration 18 months

Research Title: "Ion Transport in Beam-Plasma Interactions"

ANNUAL REPORT
for initial 12-month period 30 September 1983-1984

Principal Investigator: R.A. Stern
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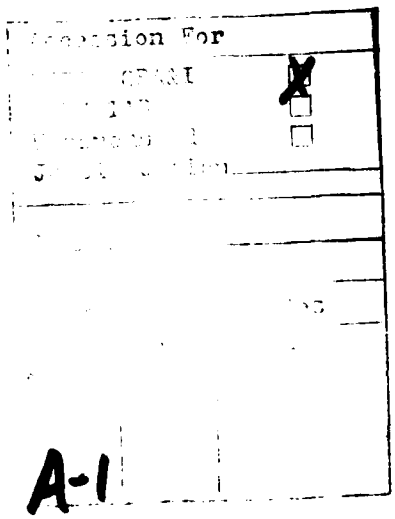

OBJECTIVE

The purpose of the project is to measure, using the novel Optical Tagging diagnostic technique, the scattering of ion beam particles and the transport of background ions, which occur during beam-plasma interactions. The program stages are:

A. construction of a miniature, modular "DP" (double-plasma) device, consisting of two independent but adjoining plasmas connected by a controllable grid interface, and fully instrumented for both conventional and optical diagnostics. One plasma serves as the source of beam ions, which are injected into the second, "target" plasma.

B. construction of a laser system capable of generating two pulses arbitrarily spaced in wavelength, time and position. These serve as "pump" and "search" pulse, which are used respectively to tag the beam ions within the source plasma before injection, and to follow their trajectory after scattering in the target plasma.

C. assembly of a detection system consisting of light transport, wavelength discrimination, and event-detection elements. The final stage is

D. test and measurement of the beam-plasma interaction physics.

CURRENT STATUS

At the end of the initial 12-month period after start of the project, task A has been accomplished, and tasks B and C are nearly completed. The details are given below.

A. Plasma Device

i. a vacuum and gas-control system has been assembled.

ii. a test chamber with multi-axial ports for probe and optical access has been constructed.

iii. a plasma source, including filaments, electrodes, power supplies and control, as well as an electron-confining magnetic field, have been put together. The entire system (i, ii, iii) has been assembled, tested and successfully operated.

iv. Langmuir probes have been constructed, instrumented, and used to characterize the plasma generated by the source in the test chamber. The plasma properties are satisfactory. To date, an unexplained high-energy electron component is detected in the plasma under a variety of conditions. We note that this component is not expected to have any influence on the processes we propose to study.

In summary, plasma device construction is essentially completed.

B. Laser System

All components for the laser system have been acquired or constructed, and their assembly stands at an advanced stage. Specifically:

i. cavities, flash lamps, dye flow tubes and pumps, mounts, mirrors and gratings for two independent pulsed lasers are on hand.

ii. two independent power systems: high-voltage supplies, energy capacitors, spark gaps and trigger circuits have been put together.

iii. one complete pulsed laser has been assembled and fired.

Work remaining on this phase of the project is: a. aligning of the laser, and b. assembly of the second laser from existing components.

C. Detection System

All elements of the detection system have been acquired and are being assembled. They consist of:

i. stand and mounts for detection optics and associated electronics.

ii. ½-meter monochromator and Fabry-Perot interferometer for wavelength discrimination.

iii. photomultipliers, power supply, amplifier and pulse detector (boxcar integrator).

Work remaining on this phase is the assembly of lenses and positioning gear for light transport from plasma to final detector (all components are on hand).

PERSONNEL

Work to date has been carried out principally by Major Howard E. Evans II, USAF, under the direction of Prof. R.A. Stern. The following changes in personnel have taken place:

1. Major Evans has returned to active duty, and is presently on the staff of AFIT, Wright Patterson AFB, charged in part with responsibility for Plasma Physics. At his request, and with the view of enhancing the level of Plasma Physics instruction at AFIT, a number of components of the Double Plasma Device have been loaned to AFIT, and were hand-carried there by Major Evans. Major Evans is in the process of acquiring the remaining elements needed to construct a copy of the Double Plasma Device, which will serve for teaching purposes, as well as for eventual completion of Major Evans' research.

2. Continuing work on the project is carried on by Paul Arndt and Peter Songas, University of Colorado students, under the direction of Prof. R.A. Stern.

3. The technical and professional activities of the Principal Investigator during the 12-month contract period are detailed on the enclosed pages.

FUTURE WORK DIRECTION

During the next few months, stages B and C will be brought to completion. Specifically, i. the first laser is expected to be aligned and lasing by November 15; ii. the second laser should be assembled and lasing by December 31. By this date the detection system will be completed as well, and stage D (testing) should start with the beginning of 1985. A condition for meeting these goals is the return of the Double Plasma Device components loaned to AFIT. In case they are still needed at AFIT, some time delay may be experienced. We view the interaction with AFIT as a positive function of this program, both with respect to Major Evans' research, and the Plasma Physics teaching program, and will adjust our schedule accordingly.

Principal Investigator Activities, Sept. 30, 83-84

R.A. Stern, Professor, APAS and Physics Departments

1. Graduate students supervised: 5

2. Ph.D. defenses completed: 2

3. Research projects: 6

sponsored by NSF, AFOSR, Los Alamos National Laboratory, and EURATOM

4. On-going national & international collaborations: 1) Los Alamos, 2) Center for Research in Plasma Physics (Lausanne, Switzerland), 3) California Institute of Technology, and 4) University of California, Irvine. Visiting Professor, CRPP Lausanne, May-August 1984; Visiting Research Physicist, UC Irvine, Dec.-Jan. 1983-84.

5. Invited papers:

Annual Meeting, Division of Plasma Physics, Nov. 83

Gordon Conference of Plasma Chemistry, August 84

APS Conference on High-Temperature Plasma Diagnostics, Sept. 84

US-Japan Workshop on Field Measurements in Plasmas, Sept. 84

6. Invited seminars or colloquia:

Ecole Polytechnique, Paris, March 84

Bell Telephone Laboratory, Murray Hill, NJ, April 84

Lawrence Berkeley Laboratory, May 84

Vaud Physics Society, Lausanne, July 84

7. Conference and organization chairs:

Basic Plasma Session, Int'l Conf. on Plasma Physics, Lausanne, June 1984

Program Committee, Division of Plasma Physics, subcommittee on General Interest sessions, 84

8. Professional activities:

Associate Editor, The Physics of Fluids

9. Invited and review articles:

"Tracking Particles by Lasers," Europhysics News 15, 2 (1984)

"Laser-Ion Beam Diagnostics for Potential and Magnetic Field Measurements in Plasmas," in press, Review of Scientific Instruments (Jan or Feb, 1985)

10. Contributed papers:

"Laser Fluorescence Measurements in a Neon Plasma with High Temporal Resolution," P. Kohler, R.A. Stern, B. Hammel, M.Q. Tran, B.M. Lamb, P.J. Paris and M.L. Sawley, Proc. 1984 Int'l Conf. on Plasma Physics, II, 317 (1984)

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